347-
Spruce Budworm
LGL-1-5
1073
1682

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH ADMINISTRATION
BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE

Project	Date	Author

TITLE

SPRUCE BUDWORM PROGRESS REPORT
1948

By

W. D. Buchanan

Forest Insect Laboratory
308 Agric. Bldg., Colo. A & M
Fort Collins, Colorado

SUBJECT—

INDEX No.—

U. S. GOVERNMENT PRINTING OFFICE 16—47272-1

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Administration
BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE
WASHINGTON, D. C.
308 Agric. Bldg., Colo. A & M
Fort Collins, Colorado
March 30, 1949

BUDWORM PROGRESS REPORT - 1948

W. D. Buchanan

In 1948 the primary object of the budworm work done by the Fort Collins, Colorado Laboratory was the same as it was during the past 3 years - that is, the collection of certain parasites for liberation in the budworm infested areas in the northeastern states. It was decided to make collections in two general areas. The first was to be made in the vicinity of El Rito, New Mexico with the object of obtaining colonies of the Larvaevorid fly, Carcelia auriesudata and the Ichneumonidae, Phytodietus fumiferanae. The second collections were to be made in the Black Hills with the object of obtaining pine form budworm pupae, and ship them to Belleville, Ontario where it was hoped that they might contain some Hymenoptera that would be of value in the northeastern states.

New Mexico Collections

A high budworm population has persisted for a number of years over many thousands of acres on the Carson and Santa Fe National Forests. White fir, Douglas-fir, cork bark fir, blue and Engelmann spruce are the hosts with the great bulk of the budworm population being on white and Douglas-fir. In some areas a considerable number of the stems have spike tops which vary from a few inches to 6 or more feet in length. Relatively few trees have been killed to date, but those with spike tops will be malformed even if they survive this budworm outbreak. Most of the stands have two or more tree species in them, but at present, ponderosa pine is considered the most valuable for saw timber.

While the budworm population appeared to be more or less comparable in several locations on the Carson National Forest it was decided to make headquarters at El Rito, because this village was closer to the infestation than other places where help and working space could be had. An examination of several thousand buds showed that about 12% of them were infested. Men and boys over 16 years of age could not be obtained to assist with the collecting work so it was necessary to use untrained high school age Spanish-American girls who required constant supervision. A total of 119.75 man days were spent by this temporary labor to obtain over 106,000 budworm larvae and an estimated 15,000 pupae. The bulk of the collections were made in two major drainages. These were El Rito Creek and the Vallecitos. The first collections were made at the lower elevations, and as the larvae matured at higher levels, collections were made there.

It became evident soon after larvae started to pupate in the rearing trays that there would be relatively few Ceromasia auricaudata obtained from them, and Phytodietus fumiferana was exceedingly rare on the larvae. Fly eggs were first observed on the larvae collected about July 3. The New Mexico work was terminated July 8. At that time it was estimated that about one percent of the larvae had pupated in the field, consequently the extremely low parasitism may not be typical of conditions that existed later. Only 1825 fly puparia were obtained. These were identified by Mr. P. B. Dowden of the New Haven, Connecticut Laboratory as follows:

265	Ceromasia auricaudata
1120	Omatoma (Winthemia) fumiferana
310	Madreymia saundersii
21	Phryxe pecosensis
12	Aplomya caesar
17	Sarcophids
4	Pupariform - undetermined

The lack of refrigeration in El Rito made it necessary to store the puparia in a cool, damp basement until shipments were made. Whether this or some other factor was involved is not known, but Mr. Dowden reported that practically all of the material was dead when it was examined at New Haven. Except for storage the methods used in 1948 were exactly the same as those employed at La Veta, Colorado in 1946 when over 11,000 Ceromasia alone were reared from about 65,000 larvae and those puparia arrived at their destination in good condition.

Colonies of fertilized Compsilura concinata were liberated near El Rito and Taos, New Mexico in 1947. Large budworm collections made at El Rito and smaller ones at Taos in 1948 in the areas where the 1947 liberations were made, failed to have a single Compsilura in them.

Special Budworm Collections

Table 2 presents data from 6 special collections made in the areas indicated. The data were lost from some weekly collections, along with those from 4 other locations on the Carson National Forest and one from La Veta, Colorado through an unintentional error by the temporary employees who combined these collections with mass material. It will be noted that total parasitism is low in all of the collections we have data for, however, the number of Ceromasia obtained is higher than it was from the mass collections.

Early in June larvae infested buds were collected with the object of determining whether Dicladocerus sp. were present, but nothing came from over 3,000 infested buds taken at El Rito and Taos. It is possible that the collections were made too late for this parasite.

In September, Dr. C. L. Massey of the Fort Collins Laboratory collected 283 pupal skins from the El Rito Creek drainage where larval collections were made earlier. An examination of these showed that moths had emerged from 260, flies from 6 or 2.12 percent of the collections, Hymenoptera from 9 or 3.18 percent, 7 or 2.47 percent were undetermined and 1 pupae had died from unknown causes.

Dr. Massey also collected 46 pupal skins from the Holy Ghost area and these were found to have had moths emerge from 42, flies from 1 and Hymenoptera from 3. This percentage of parasitism is somewhat lower than it was in the special collection shown in Table 2 from El Rito, but it is not too different from the parasitism obtained in the mass collections.

Budworm Populations

In the spring of 1947 numbers were placed on 10 or more trees ranging from 5 to 7 feet in height in each of 7 plots. The trees were comparable in size and were not overtopped by larger budworm host trees. In all of the plots other than those on the Uncompahgre National Forest there are two or more tree species in each plot. The results of the collections to determine host populations is recorded in Table 1. The number of larvae present in 1948 is smaller in all cases than it was in 1947. The reduction in budworm populations on the numbered trees may not be characteristic of the situation in the plot areas because observations by W. G. Wellington and others indicate that fully gravid females cannot fly until they have laid one or more masses of eggs. If this applies in all cases it means there were fewer eggs laid on the trees by the 1947 moths than there would have been if the larvae had been allowed to remain and the moths oviposited before leaving the trees. The larvae present on the trees in 1948 obviously had to come from eggs that were laid by moths that developed on other trees. The budworm population in the Spring Creek area of La Veta, Colorado is estimated to be lower than it was in 1947. It required 6 man hours to get 250 larvae.

Budworm Racial Studies

For some time there has been a question as to whether the budworm that feeds in this area on ponderosa pine is the same species as the one that works on the firs and spruce. In 1947 a number of attempts were made to cross pine form males with fir form females, and fir form males with pine form females. Unfertilized females were placed in pint fruit jars and exposed to one or more males, but mating was observed in only 2 cases and both of them were between pine males and fir form females. The 2 females laid fertile eggs, and the larvae that hatched spun their hibernaculae inside the jars. These jars, as well as some containing larvae that hatched from fir form parents, were placed in the unheated museum at Rocky Mountain National Park to hibernate on September 14, 1947. No fertile eggs were laid in the jars from pine form parents. On January 29, 1948 the jars were taken to the Fort Collins Laboratory where the larvae that survived were placed on Douglas-fir and ponderosa pine seedlings, and also on some branches from ponderosa pine, Douglas-fir and blue spruce that had broken dormancy in the laboratory. Survival of the larvae stored at Rocky Mountain Park was very poor. The larvae in one of the jars from the pine male and fir female cross died, but in a second jar most of the larvae of this cross survived. Table 3 shows the number of larvae from each jar, and the material in the jars for the larvae to hibernate on. The majority of the females placed their eggs on the sides of the jars and pieces of paper placed inside. The larvae spun their hibernaculae in sawdust or cotton when they were present. Some of the larvae crawled deep into wads of cotton and it seemed hard for them to get out of it after they broke dormancy. A good deal of thought and time was used in trying to rear the larvae on various foods and in different containers.

The number that developed to moths was very disappointing and little was learned from the work. All of the larvae from the pine form male and fir form female cross died soon after they were placed on foliage. Tables 4 and 5 present data obtained from attempts to rear the larvae on the foliage indicated. Space was not available to run these rearing experiments outside a laboratory room where some insecticides were being opened, and even though care was used, it is possible that small quantities of DDT powder, for example, which was observed to fly out from a can that was opened, settled on some of the foliage and killed larvae that was placed on it. Water proof cellophane cages were tried, but it was found that there was too much condensation inside, so a type of cellophane that would permit evaporation was tried and proved to be satisfactory. These transparent cellophane cages, as well as the 8 dram vials, made it possible to observe the larvae and host material without disturbing either. Fir form larvae that developed on a diet of ponderosa pine were typical of moths that developed on blue spruce and Douglas-fir, but the number is so small that conclusions cannot be drawn.

Plans were made to do further work in 1948, but circumstances beyond control made it impossible. This was due to the fact that pine form moths, which are later in developing than the fir form, had not started to emerge by the time the work had to be terminated in New Mexico, and it was considered unsafe to take fir form specimens into the Black Hills due to the possibility of specimens getting away and attacking white spruce in that area. Both species had completed their development by the time the Black Hills work was terminated, consequently it was impossible to do anything. It is hoped, however, that this work can be followed up and enough data obtained to draw conclusions as to whether there are specific differences between the fir and pine form.

Black Hills Budworm Collections

In 1947 an extensive outbreak of the pine form budworm was observed by N. D. Wygant and others on ponderosa pine in the Black Hills. In 1948 high larval populations caused considerable defoliation to most of the areas affected in 1947. It was decided to terminate the work in New Mexico in time to reach the Black Hills before the pine form budworm began to pupate. The objective being to collect mature larvae from several locations to obtain information on the parasite complex and percent of parasitism, and make mass collections of budworm pupae and ship them to the Canadian parasite laboratory at Belleville, Ontario where the parasites could be reared for liberation in the northeastern states if anything important was present.

Examinations made in several areas in the Black Hills from July 15-18 showed that most larvae were mature, and pupation was well along, but it was most surprising to find that the budworm population was exceedingly low. With the assistance of 7 girls and a boy from Sundance, Wyoming a collection of 20,776 badly injured ponderosa pine tips was made in the William Springs area of the Spearfish Ranger District. An examination of these tips revealed the following: about a dozen larvae; 117 budworm pupal skins from which moths had emerged; 214 live pupas, and 67 pupal skins from which parasites had emerged; a few Glypta fumiferana and 747 Apanteles fumiferana cocoons. Each of the 20,776 tips should have had an average of at least one parasite or budworm in it.

In the William Springs area an examination of 120 trees ranging in height from 1 to 12 feet showed that 42.73 percent of the tips had been fed upon. It is believed that this figure is lower than the average number of injured tips in larger trees because counts made from the ground indicated that practically all the tips in those trees were injured.

An effort was made to get some clues as to what caused the population to disappear, but no satisfactory explanation is available. It was reported by Ranger Korb of the Spearfish District that following a 6 day rain prior to July 12 he noted some budworm larvae that were "goocy". An examination of that area about 2 weeks later failed to reveal any larval remains other than an occasional one that may have been killed by such larval parasites as Glypta or Apanteles. It would seem that if any number of larvae had died from either disease or parasitism more of their remains would have been found on the trees. The dearth of birds in the Black Hills made it seem unlikely that they destroyed any great number of larvae and pupae. Examinations of injured tips in several localities in the Black Hills indicated that the budworm population had gone down in all of them because it was very difficult to find pupal skins.

A collection of 72 live budworm pupae from the William Springs, South Dakota are was found to have:

22 Hymenoptera - largely Itoplectus conquisitor
7 Diptera - Actia
18 Moths
25 Pupae died from unknown causes

A collection of 43 pupal skins found in the tips from which the above live pupae were obtained had Hymenoptera emerge from 38, flies from 5 and none of them had moths emerge.

It is unfortunate that observations were not made earlier in the season in the Black Hills but the writer and other members of the Fort Collins staff were tied up on other problems which made it impossible. It appears that there should be relatively little budworm damage to ponderosa pine in the Black Hills in 1949, but it may be a year or two before some of the badly injured trees recover from the damage that has been done to them. It was surprising to find that secondary parasites were present in a good many Apanteles cocoons that were found on the tips. Apanteles were far more abundant in the budworm injured tips than all other primary parasites put together. It is a question as to what will happen to the budworm population in the future if the secondaries continue to destroy a great many of this primary species.

Woodland Park, Colorado Infested Area

In October an examination was made of a budworm infested area near Woodland Park, Colorado that covers a little more than one township. This infestation is a residue of one that covered most of the Douglas-fir stands on the eastern slope of Colorado prior to 1926. Ranger Bradshaw at the Woodland Park Station stated that the area is gradually getting smaller. There seems to be no good explanation for the budworm to have persisted in this small area and died out over the rest of the slope. Considerable damage is being done to a very dense stand of yound Douglas-fir, and it would seem to be a good place to make some studies on parasitism and other factors that may be involved in the eventual reduction of the budworm population in that locality.

TABLE 1. BUDWORM LARVAL POPULATION ON THE SAME TREES SAMPLED IN 1947 and 1948 IN THE LOCATIONS INDICATED

Plot Location	Number Trees	Av. No. Larvae 1947	Av. No. Larvae 1948	Remarks
LaVeta, Colo.	10	9.7	4.5	6 white fir & 4 Douglas-fir
Taos, N.M. Plot 1	10	100.2	72.7	4 Engelmann spruce & 6 blue spruce
Taos, N.M. Plot 2	10	70.0	42.4	5 corkbark fir, 2 D.fir & 3 E.spruce
El Rito, N.M.	10	151.1	101.3	7 white fir & 3 Douglas-fir
Uncompahgre N. F.			no collect.	
Douglas-fir	22	11.0	"	Trees all Douglas-fir
Alpine fir	15	3.4	"	Trees all alpine fir
Engelmann spruce	14	4.8	"	Trees all Engelmann spruce

TABLE 2. SPECIAL BUDWORM COLLECTIONS FOR DATA ON PARASITE COMPLEX AND PERCENT PARASITISM

Location	Larvae		Larval Parasites			Pupal Parasites				Pupae	Moths		Percent
	Collected	Died [2]	Glypta	Apanteles	Others	Ceromasia	Cnaterna	Hadreymia	Others	Died [3]	Emerged	Lost	Parasitism
El Rito [1]	1500	227	81	73	4	9	24	15	15	27	913	112	22.8
Rio Ghiguito (Taos)	300	28	17	8	0	1	5	2	2	4	207	26	15.3
Aqua Piedra (Taos)	500	53	16	11	1	3	5	3	5	5	388	10	15.1
El Rito (Lower)	1000	206	34	10	3	3	19	8	13	21	609	74	29.2
Taos Plot 1 [1]	1000	121	42	29	2	5	11	8	20	18	690	54	19.3
Taos Plot 2 [1]	1000	103	28	47	2	4	9	18	17	45	562	165	23.5

1/ Taken from exact area where Compsilura concinata were liberated in 1947.

2/ Some of these larvae were probably killed by parasites.

3/ Does not include pupae killed by entomophagous insects.

TABLE 3. SURVIVAL OF HIBERNATING BUDWORM LARVAE STORED IN MUSEUM AT ROCKY MOUNTAIN NATIONAL PARK

Jar Number 1/	Surviving Larvae	Jar Contents
C- 1	1	Small amount of fresh sawdust and piece of paper.
C- 2	2	" " " " " " " " "
C- 4	46	" " " " " " " " "
C- 5	42	" " " " " " " " "
C- 6	1	" " " " " , alpine fir tips & piece of paper
C-12	110	Several alpine fir tips and nothing else.
No Number	81	" " " " and absorbent cotton.
B- 6	31	One ponderosa pine and one alpine fir tip.

1/ Larvae from fir form parents except those from B-6 which are from a pine form male and fir form female cross.

TABLE 4. RESULTS OF LABORATORY TRIALS TO REAR FIR FORM BUDWORM LARVAE ON DIFFERENT HOSTS IN RACIAL STUDY

Tree Species Used	Number Larvae and Type Cage	Larvae Died Instar[1] 2	3	4	5	6	Percent Larval Mortality	Number Larvae Pupated[2]	Days as Larvae	Number Moths Emerged	Days as Pupae	Remarks
Blue Sp.[5]	Vials[3] 45	27	4	3	5	1	86.9	5	21-28	5	31-42	Moths typical fir form
	Cages[4] 20	19	1	0	0	0	100.0	0		0		
Doug. Fir[6]	Vials 19	12	2	4	0	0	94.7	1	39	1	53	" " " "
	Cages 24	24	0	0	0	0	100.0	0		0		
P. Pine[7]	Vials 56	43	12	1	0	0	100.0	0		0		" " " "
	Cages 60	51	1	2	2	0	93.3	4	31-48	4	32-58	
LP Pine[8]	Vials 24	19	4	1	0	0	100.0	0		0		
	Cages 0	0	0	0	0	0						

1/ Instar reached by larvae was not determined with accuracy in all cases but it is believed that these data are approximately correct.

2/ Refers to number of days between time when larvae broke dormancy and pupation.

3/ Vials were 8 dram capacity - food was placed inside with larvae and vial stoppered with cotton.

4/ Cages were cellophane envelopes placed over the tip of food material.

5/ Blue spruce tips used in these tests were brought in from field trees and placed in water. When buds started to swell they were exposed to larvae.

6/ Some Douglas-fir seedlings and tips from field trees were used. In some cases buds had opened when exposed to larvae.

7/ Ponderosa pine seedlings and tips from field trees were used. Buds were expanding but no new foliage developed when exposed to larvae.

8/ Only tips from lodgepole pine tips brought in from the field were used. In most cases buds had started to expand when exposed to larvae.

TABLE 5. RESULTS OF LABORATORY TRIALS TO REAR BUDWORM LARVAE FROM PINE FORM MALE AND FIR FORM FEMALE CROSS ON DIFFERENT HOSTS IN BUDWORM RACIAL STUDY

Tree Species Used	Number Larvae and Type Cage	Larvae Died Instar 2	3	4	5	6	Percent Larval Mortality	Remarks
Blue Spruce	Vials 3	3					100	Larvae used in this test were given foliage similar to that fed to fir form larvae reported in Table 4. These larvae died before any worthwhile comparisons could be made between them and the fir form larvae.
	Cages 0						100	
Douglas-Fir	Vials 11	6	1	4			100	
	Cages 2	1	1				100	
Ponderosa Pine	Vials 11	4	7				100	
	Cages 3	3					100	